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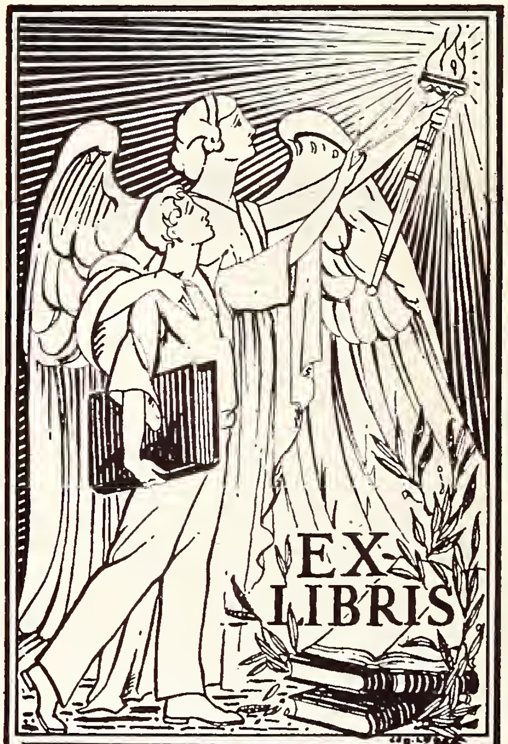
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matter, lay near the surface of a lung closely united to the walls of the chest.

7. Serous râles.—It is opportune to mention here *serous râles*, which are the least viscid of all râles. These are only occasionally heard in the chronic lesions of pulmonary tuberculosis under conditions which are little understood. It seems as if the lesion had been flooded with a non-viscid fluid through which air bubbles. They are very numerous, and burst without the characteristic delay of the mucous râle. It seems as if the rupture of the bubble were not attended with resistance, and the sounds have a peculiar soft breezy quality which cannot be described. The phenomenon is usually transient. In addition to the sound produced by the various kinds of râles, there is also to be noticed a slight vibration communicated to the stethoscope when the site of the râle is immediately beneath it. This sensation, like that produced by the voice, may sometimes be distinctly felt by the hand. It is usually very strongly marked in the case of the mucous and sonorous râles, less in the crepitant, and still less in the sibilant. When the râle has its site remote from the point where the stethoscope rests, although it is heard very strongly, no vibration is felt; and when vibration cannot be felt at any point on the chest we may conclude that the cause of the râle lies in the central parts of the lung. The mucous and crepitant râles are only heard close to their site of production. The other varieties may be heard through the whole width of the chest, and are often combined with the former. We sometimes hear a mucous râle in one side of the chest and at the same instant hear a sonorous râle which has its seat in the opposite lung.

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THE GENERAL SIGNIFICANCE OF VISUAL TESTS*

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EVERYONE who must specialize, to do honest and thorough work in any branch of medicine or surgery, must also keep a broad interest in the work and progress of other branches, or he will lose touch with the general advance of our profession and drop out of line, lose contact with the knowledge, progress and service of his day. Because in these meetings we must take time for the general bearings of all special knowledge, it seems not out of place to consider some general aspects of the tests of vision already more or less familiar to those who give special attention to the recognition and treatment of visual defects.

Tests of vision include both subjective and objective elements; and to understand them well, they should be tried by the physician on himself. A good one to begin with, is to test your own *vision with closed lids.* This is the kind of vision possessed by an eye with mature cataract. By making the experiment on yourself you can know just how an eye with cataract, or a dense leukoma of the cornea, or a vitreous filled with dense opacities, *really sees*, although it may be blind for industrial purposes. Stand before an electric lamp, turn it off, and wait two to five minutes for the eyes to become adapted to darkness. Then, with the eyelids entirely closed, but facing the lamp, turn on the current. Immediately the field of vision will be lighted, and the red colour of light coming through the lids is very noticeable.

By turning the eyes in various directions, you can notice if you are looking toward the light, and its position in relation to yourself as you move about. Marked changes in colour can also be noticed after the eyes have become somewhat adapted to the general red colour of the light coming through the lids. A certain amount of light reaches the retina through the lids, sclera and choroid, while we are using our eyes. The retina is functionally adapted for seeing under these conditions, and its state of adaptation

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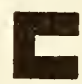
should be taken into account with all visual tests. The adaptation of tests to the particular case will always remain a duty of the physician.

In *testing for blindness*, our visual tests must often be wholly objective. In this way we can judge the vision of an infant, a lunatic, or a malingerer. The pupil reactions generally give a good idea of vision, although in some cases paralysis of iris-sphincter, or pupillary adhesions, may prevent any reaction. A cortical or sub-cortical cerebral lesion may cause complete blindness, without any loss of light reaction of the pupil. But these cases are extremely rare, and nearly all of them have a history or symptoms pointing to such a lesion. Of course, coincident disease, affecting the motor nerve supply of the iris, as in the Argyll-Robertson symptom, must be considered. The Wernicke hemianopic in-action sign is of little value when attempted by refined laboratory methods and apparatus, but it is helpful when used by alternately covering the eyes with the hand, as described by Fisher of London.

In testing the vision of infants we must look at the pupil, but should also watch the reaction of the whole child. The room should be partly darkened, but light enough to give the conditions under which the child has been accustomed to make what use it can of its eyes. An electric flash-light, held near its point of fixation, and afterward toward the periphery of its normal field, will at once command the attention of a seeing child. The turning of the head toward the light, or following the light when its position is changed, indicates both light perception and a field of vision. Continued and varied tests of this kind give a fair idea of the acuteness of vision and extent of the field. The insane or the malingerer may *refuse to look in the direction of the light*, which indicates a definite conception of where the light is. And a mental fault is also shown by refusal of an older child or adult to fix his gaze upon the end of his own finger, as the person who has become blind can and will do.

Tests of vision with charts of letters or numerals have been the most common and important of visual tests. But unless certain precautions are taken such tests may be quite inaccurate and misleading. Test letters are very convenient, and they always will be important for the subjective testing of refraction. But no series of letters can furnish a scientifically accurate test for vision. The letters are useful because they differ in form, but the different forms differ in visibility. Snellen selected capital "block letters," that could each be inscribed in a square, of which each side would subtend an angle of five minutes. But in his first tests he found that the different letters of the same size were distinguishable at different distances, and he, therefore, rejected some letters of the alphabet as unsuited for such use. The letters were printed in lines, each line marked as visible at a certain distance—20 feet, 30 feet, 40 feet—where each letter subtended the angle of five minutes. Yet with average normal eyes, only two 20 feet letters, B and S, were just visible at 20 feet. Snellen insisted that all the letters on a line must be recognized. Some letters of the same size could be seen at 25 feet, others at 30 feet, and a few at 40 feet. Yet Snellen proposed his method of recording vision by vulgar fractions, using the distance at which the letters could be read as the numerator, and the distance at which they were numbered to be read as the denominator, as 20/30ths, and 20/40ths, etc. He soon found the letters he had first chosen were not equally visible and re-



An incomplete square. This size for use at ten metres.

jected some of them. Other users modified the forms of the letters used. John Green used "half-block" letters, in the effort to make them more uniformly visible. Others tried the Gothic letters, because simpler, or they reduced still more the number of letters employed. But many of those who have used cards of test letters recognized their departure from any scientific equality, and added a minus sign when not all the letters of a line were recognized, or a plus sign when some smaller letters were also recognized. Thus we have records like 20/20 minus 2, or 20/30 plus 3—records having no exact value unless the particular letters, seen or not seen, were noted, like 20/30 minus S.

Snellen later introduced other figures into his lines of test letters, a cross, a circle and particularly the *incomplete square*. Each side of such a square subtended an angle of five minutes, but one side was omitted. The omitted side made a good test, but it left an opening of three minutes instead of one minute, the angle originally chosen for the width of the lines and open spaces. On this account Snellen introduced a middle bar in the square, making what he called "Haken,"

(hooks) but which is usually known as "the Snellen E."

Landolt proposed the *incomplete ring*, which was adopted in 1909 as the international test for visual acuity. It is a ring of five minutes in diameter, but with a part, subtending an angle of one minute, left out on one side. The writer has modified the incomplete square, by making it *three minutes* on a side, with the break of one minute on one side. (See Fig.) Such figures constitute our best tests for visual acuity. And the best way to use cards of test letters and know the real visual acuity is to mark the lines of letters to correspond with such standard tests.

But with ideal tests other things also must be taken into account. Years ago the clinical assistants at Wills Hospital used to make records of vision like this: V. = 20/40, "dark day," and were not surprised when the same eye on a bright day showed V. = 20/15. The illumination of the test card and of the background, or the field surrounding the test, must conform to some standard, and the previous exposure of the eye to light must be known before we can have a record of the vision that is scientifically accurate and suitable for future comparison, either from day to day in acute disease, or in after years for an advancing cataract. But when we have an exact scientific record, in the usual form of 20/20 or 22/100, we have only attained a very small part of the general significance of what may be learned from visual tests.

Our best test cards give only the acuteness of vision in the region of the fovea, at the centre of the yellow spot. As measured by such tests, the *acuity of the peripheral parts of the retina* is generally very much less than that at the fovea, but for some purposes the vision of a part of the retina 40 degrees, or 90 degrees, away from the fovea is much more important. To catch instantly the presence of an automobile coming on a cross street, to find a four-leaf clover, or a weed in the lawn, or a coin or a ring that has been dropped, we must depend on the sensation from peripheral parts of the retina. In scotopic vision, seeing at night or in the twilight or dawn, the periphery of the retina is more sensitive than the macula. It is quicker to perceive slight movements. The small animal or bird we see holding its head very still, "frozen" as the naturalists say, is looking with its whole retina, watching in every part of its field of vision to detect its food or enemy. Peripheral vision is very important to the lower animals, and in some occupations, or as an evidence of commencing disease; it may be more important than a high standard of central or macular vision. The loss of peripheral vision may cause more disability than great reduction of visual acuity, as we estimate it with test letters.

To take up the different tests for the field of vision, and the special significance of each form of impairment of the field in the domain of pathology, would be another story, and a long one. Even striking cases, like the tubular fields of retinitis pigmentosa and quinine blindness or of hemianopsia, such as once made certain the diagnosis between a small cerebral hæmorrhage and intoxication, or which, in another case, was the first definite sign of cerebral progressive softening, cannot here be dwelt upon.

But one old method of testing the field of vision, unknown to some and fully appreciated by few, is the *confrontation test.* Doctor and patient confront each other, eye to eye. The doctor looks with his right eye, the patient with his left eye, or vice versa, each with the other eye closed. Then their two fields of vision coincide on the plane half way between them. The doctor brings his fingers into the periphery of the field, and has the patient tell him when they are still, or when he moves them. This has the certainty of an objective test. The apparatus is always at hand. The patient's powers of observation and honesty çan be judged; and it is a means of training the patient for field-taking that I always resort to, whatever means of recording the field may be used afterward.

Nothing has been said of colour blindness or the tests for colour perception. Our knowledge of colour testing is still fragmentary and recent. But for certain occupations the importance of full normal colour sense cannot be too strongly emphasized. Probably the number of traffic accidents, on sea, or land, or air, that are due to defective colour sense is still much underestimated. Most of the dangerous colour-blind persons do not know that they are colour-blind. Even if they suspect some defect in their vision, they say nothing about it when an accident has occurred. And only in a few places has there been systematic search for the defective colour-sense that might have caused a serious accident. On the other hand, the mass of tests that have been made in railroad and marine services for colour-blindness have been by routine methods, not calculated to detect all sorts of cases; and these were applied with a bias against throwing

anyone out of his accustomed means of livelihood, because of a defect that is rarely felt in ordinary life and have been regarded as chiefly of academic interest. As to the recent use of colour signals for automobile traffic and in aviation practically no statistics as to dangerous colour defects have been gathered.

With regard to the significance of impaired colour-sense in disease very little is known, and many of the observations that have been recorded are of doubtful interpretation. The methods of mapping the visual fields for colours are based on apparatus and technique that apply chiefly to the testing of cone-vision near the centre of the field. It is still uncertain if narrowing of the field for colours has any significance, other than that which attaches to narrowing of the field for black and white, as tested by smaller test objects. Alterations in colour-perception may yet be found that will give early and significant evidence of disease, but up to this time there is little of importance recorded on this subject.

The broader and more important aspects of vision and tests of vision are only becoming manifest as we learn more of the evolution of this sense, which dominates the civilization of our time. Within the last ten years, three "Bowman lectures" have been given, before the Ophthalmological Society of the United Kingdom, and published in its Transactions, that have changed our conceptions with reference to the sense of sight and many of its relations. The first of these, in 1921, by Mr. Treacher Collins, took up the changes that came to the vision and ocular movements of our arboreal ancestors. When the primates began to live in trees they escaped from many of their enemies, had less need of the wide field of vision gained by eyes placed on opposite sides of the head; but they needed accurate seeing for small objects, and exact judgment of short distances, secured by the eyes being placed in front, where they could cooperate in a new kind of vision, binocular vision, exactly secured and maintained by accurate binocular movements. They also gained, what they needed, accurate discrimination of colours, even of small objects.

In 1925 Sir John Herbert Parsons took up what he called "protopathic" and "epicritic" vision. The former, possessed by the lower vertebrates and mammals up to the monkeys, included the wide field of vision extending sometimes to the whole horizon, the very quick perception of any movement, and the ability to have serviceable vision by feeble light, scotopic vision. It did not include accurate vision for small near objects, or binocular vision, or very accurate binocular movements. These came with what is called "epicritic" vision. The sense of sight became in a high degree discriminative, in direction, colour and relative distance.

In 1928, Elliott Smith, one of the professors of anatomy in the University of London, perhaps our greatest teacher of the anatomy and comparative anatomy of the central nervous system, lectured on the development of the macula and of the visual tracts and connections—the great mass of cerebral convolutions, to which he has given the name of the "neopallium." He pointed out that the macula, with its thickly massed retinal cones, each with its independent connection with the central nervous system, differed essentially from the percipient rods of the retina in that several rods were connected with a single nerve cell and nerve fibre. He showed that the development of the macula, the increase of fibres in the optic nerve and tracts, and the development of the "neopallium" all came together. This implied that this new development of epicritic vision, this mind for visual coordination and comparison, its wealth of visual memories, a dominance of sight over the sense of smell, as expressed in the relative size of brain convolutions, this governing of movements and actions by vision, this voluntary and purposive control, came with the development of accurate macular vision.

In 1861, Ezra Dyer was studying with Snellen in Donders' Clinic, at Utrecht. Late in that year he returned to Philadelphia, and met S. Weir Mitchell, the foremost American neurologist of his time. He met Mitchell's favourite question, "What's new?", and talked with him about the work Donders was doing, about the visual test that Snellen was working up, and which Dyer got printed for his own use, some months before the first edition of Snellen's test-types had appeared. Dyer began measuring the refraction of Mitchell's patients. From the union of these active minds came ideas of eye-strain and resulting nerve-strain with its influence on metabolism, that are still developing and extending our control of the disabilities and suffering that arise from ocular defects and in many of the emergencies of life.